

high radiation doses to workers in these areas (e.g., reports of continuous sampling for February and March 1959 indicated an average of 10 and 27 dpm per m<sup>3</sup> respectively in the neptunium recovery area in C-710). In September 1961, magnesium fluoride pellet traps were installed in the feed plant to capture neptunium and technetium; in January 1963, similar traps were installed at the C-310 product withdrawal stations. By March 1962, neptunium recovery operations had ended, and in June 1963, technetium recovery operations also ceased. A different technetium recovery process was initiated in the mid-1970s to remove technetium from aqueous waste streams for the purpose of environmental protection.



**Aerial View of PGDP Circa 1952**

Before the mid-1970s, a complex uranium recovery process was operated in C-400 for separating uranium from waste and scrap materials, concentrating it, and converting it to an oxide. The uranium recovery system was not leak-tight, and leaks were common. However, steps were taken to control operators' exposure to process materials. Routine surveys were conducted to monitor the concentration of radioactivity on surfaces and in the air in C-400, and the health physics staff recommended changes in work practices based on the results of these surveys. In the mid-1970s, the solvent extraction process for uranium recovery was replaced with a simpler precipitation and filtration process. The filtrate, containing low concentrations of radionuclides, was discharged to the environment via the C-400 drains. Sludges and filter cake were processed at PGDP for uranium recovery or sent to Fernald for recovery.

From December 1956 through December 1962 and from January 1968 through October 1973, PGDP produced UF<sub>4</sub> and uranium metal in C-340 for weapons uses. The uranium metal production process involved reducing UF<sub>6</sub> (normally from the tails cylinder) to UF<sub>4</sub>

by combining it with hydrogen in a heated tower. The UF<sub>4</sub> was mixed with magnesium and fed into lined firing reduction vessels (commonly referred to as "bombs"), placed in furnaces, and heated until it fired into a metal ingot, called a "derby." The derbies were removed from the bomb, cleaned, cut, and shipped to Oak Ridge. This process created a dusty environment in the metals plant with airborne UF<sub>4</sub> and magnesium powders, uranium metal oxides, radionuclide uranium daughter products, and magnesium fluoride dusts. The production of UF<sub>4</sub> continued until 1977, primarily to provide HF for feed operations. Working conditions were dirty, with airborne uranium and HF leaks. The use of army assault masks or respirators was specified for many metals plant activities, although workers did not always use them. The metals plant was responsible for much of the fluoride released to the environment at PGDP.

During the 1950s and 1960s, in order to retain certain skills and to maintain local employment levels after initial construction, a variety of non-enrichment work for other Federal agencies was performed. These activities included manufacturing missile components, superconducting electromagnets, and fuel shipping casks. In addition, until 1985, disassembly of weapons components and recovery of metals were performed at PGDP. While the work involved limited amounts of hazardous materials (e.g., lead), the primary exposure risk to workers on these projects was presented by normal Plant work activities in adjacent areas of the buildings. Nickel and aluminum recovery was performed in three smelters in C-746A; gold recovery occurred principally in the C-746A disassembly room and in C-400. Primary hazards in smelting operations were heat, working with molten metals, noxious fumes, and some potential for airborne radioactive contaminants.

## 2.3 Maintenance and Modifications

Much of the exposure to radioactive and hazardous materials at the PGDP resulted from system maintenance and improvement activities. The amount and complexity of equipment in continuous operation at high speeds, temperatures, and pressures resulted in frequent intrusions into piping systems to repair valves, compressors, motors, feed pulverizers and conveyors, and supporting piping and components. Opening of systems and components exposed residual UF<sub>6</sub> to moisture in the air, forming caustic HF gas and depositing uranium fluoride (UO<sub>2</sub>F<sub>2</sub>) around the immediate area. Changing of dust bag collection filters in process buildings

and C-340, C-400, C-410, and C-420 could have exposed maintenance mechanics to concentrated inhalation and contamination hazards.

Several formal cascade improvement programs (CIPs) and cascade uprating programs (CUPs) involving replacement of major components to increase diffusion process reliability, capacity, and efficiency started as early as 1954. The second major CIP/CUP started in March 1973 and continued for eight years. This CIP/CUP process involved cell by cell removal of compressors and converters, process piping, and support system components while the remainder of the cascades remained in operation. After removal, compressors and converters were taken to C-400 for disassembly, cleaning, and decontamination and then to C-720, where they were modified and reassembled prior to reinstallation. In addition to releases of  $UF_6$ , these disassembly activities exposed maintenance workers to transuranics and fission products adhering to surfaces inside the system and to trichloroethene (TCE) during degreasing and decontamination. Workers could have received significant radiation exposures by inhaling neptunium-237 dust. At the completion of the CIP/CUP activities, converter and compressor disassembly remained a routine operation.

Between March and May of 1977, C-340 underwent a slow and deliberate shutdown for an indefinite period. During the shutdown period, which lasted until the mid-1980s, Building C-340 was used as a valve rebuilding shop and routine maintenance facility.

## 2.4 Unusual Occurrences and Accidents

During its first 40 years of operation, PGDP experienced numerous operational upsets, releases, exposures, and other accidents. Documentation, investigation, and reporting of these unusual events were very inconsistent and infrequent until the initiation of DOE's formal occurrence reporting systems in the late 1980s. One of the most frequent and notable unusual events was the release of  $UF_6$  gas into work areas or the environment. The releases ranged from very small amounts, commonly referred to as "puffs," to significant amounts that resulted in HF burns, and uranium intakes requiring bioassay or medical attention for dozens of workers. The sources of these releases included the process system during system upgrade work, equipment failures, and maintenance activities; cylinder connection and disconnection activities at feed and withdrawal stations; and process equipment disassembly during shop maintenance activities in C-400 and C-720.

Several evaluation reports on  $UF_6$  releases and their effects, as well as other site documents, identified approximately 50  $UF_6$  releases, each in excess of 10 pounds of uranium. However, reviews of health physics reports and the site quarterly progress reports from the early 1960s revealed references to many hundreds of releases of varying sizes (described often only as minor, large, or major). These reports identified many employees who were exposed from these releases and required medical examinations and bioassay. Burns and respiratory tract bleeding from exposures to or inhalation of HF were frequent occurrences. Many health physics reports indicated that these releases were not documented in operations shift logs and were often not addressed in the Plant's quarterly progress reports to the AEC, which was the regulatory agency at that time.

At least 15 events were identified in the first ten years of Plant operation that each released a minimum of 100 pounds of uranium, with a 1960 event releasing approximately 6,800 pounds and a 1962 event releasing approximately 3,400 pounds. As better equipment was installed and major system upgrade work ended, operational practices improved and the number and quantity of  $UF_6$  releases decreased significantly. In the 1980s, reported releases were on the order of one to five per month and were measured in grams instead of pounds. The number of persons placed on recall for bioassay decreased from 30 or more per month in the 1950s to one to six per year in the 1980s.



**C-337 Fire and Explosion - December 1962**

Other significant Plant events included a major fire in Building C-310 in 1956, overexposure of two maintenance mechanics to beta radiation, and an explosion and fire in C-315 in 1978. Major releases affecting groundwater included a spill of 17,000 gallons of diesel oil migrating as far as 2 miles from the site boundary via surface water and the identification of